First observation of an atomic level in the element nobelium

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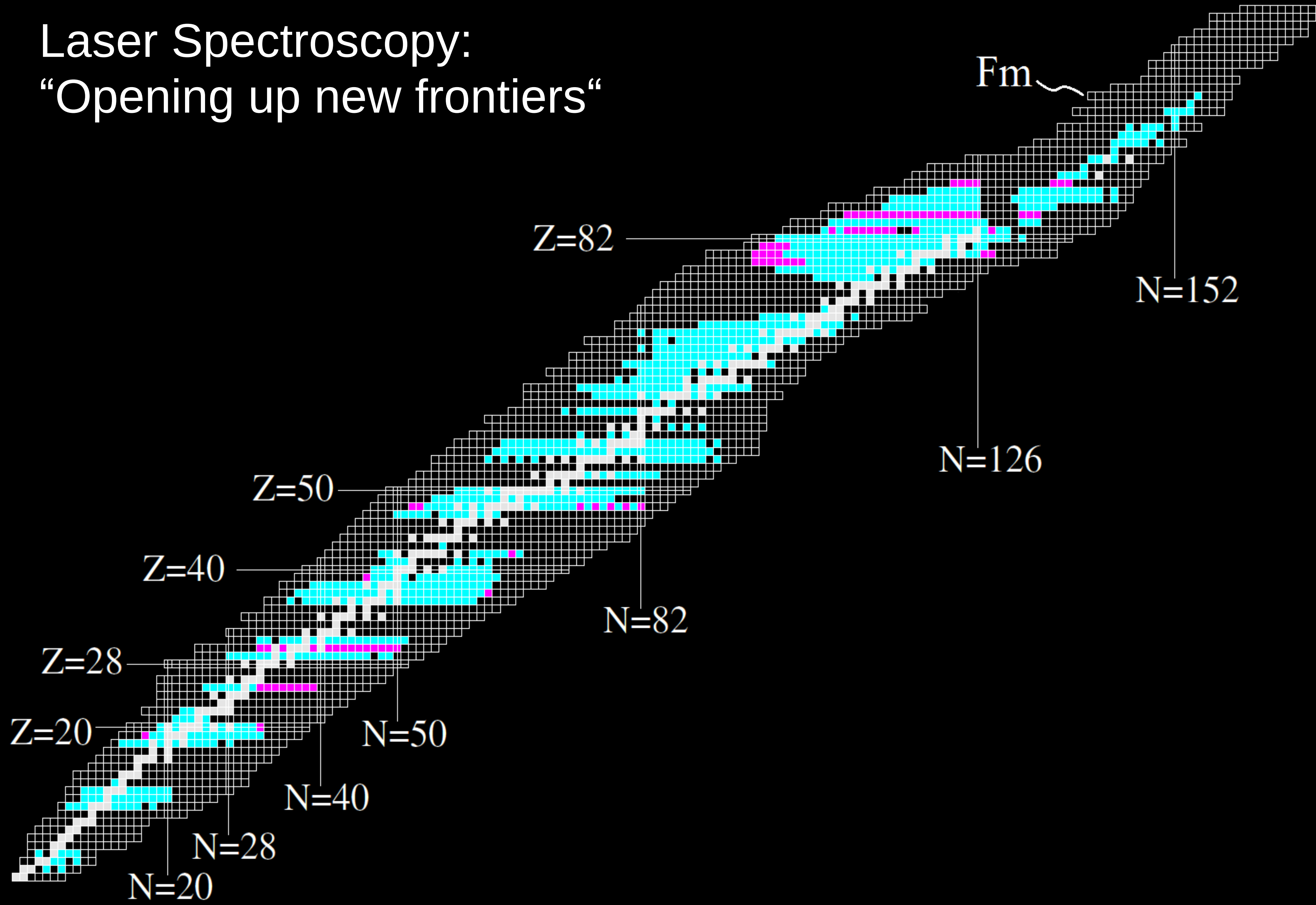
Outline

- Motivation
- Experimental method
- Level search in ^{254}No
- Conclusions & future prospects

Laser Spectroscopy:
"Opening up new frontiers"

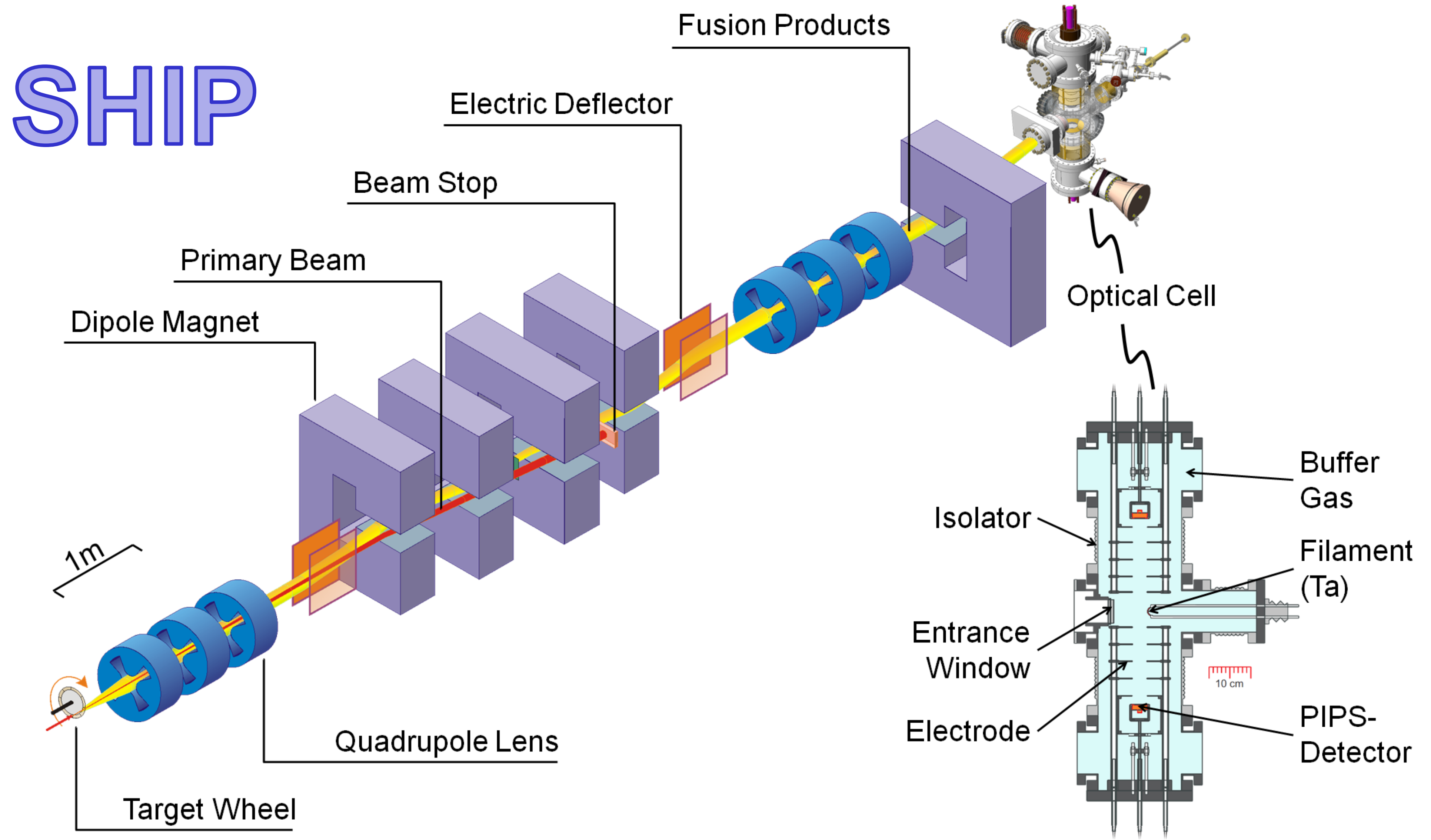


Nobelium isotopes

- Element of interest: No (Z=102)
  - GS: [Rn]$5f^{14}7s^{2}\ {}^{1}S_{0}$
  - Relatively high production cross sections

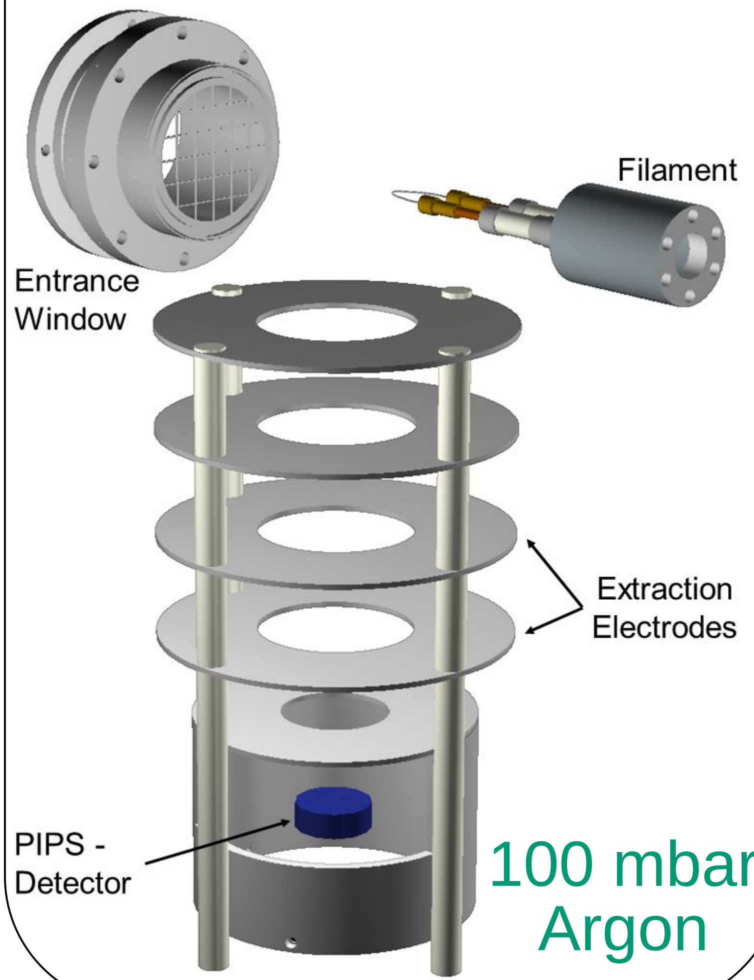
Isotope	I^P	$T_{1/2}$ (s)	Nuclear reaction	Production rate @ $1\mu A_P$ (1/s)	α- energy (MeV)	α-branching (%)
^{252}No	0	2.1	^{206}Pb(^{48}Ca,2n)^{252}No	4	8.42	73.1
^{253}No	(9/2$^-$)	102	^{207}Pb(^{48}Ca,2n)^{253}No	11	8.01	80
^{254}No	0	55	^{208}Pb(^{48}Ca,2n)^{254}No	17	8.10	90
^{255}No	(1/2$^+$)	186	^{208}Pb(^{48}Ca,1n)^{255}No	2	8.12	61.4

Radiation Detected Resonance Ionization Spectroscopy (RADRIS)

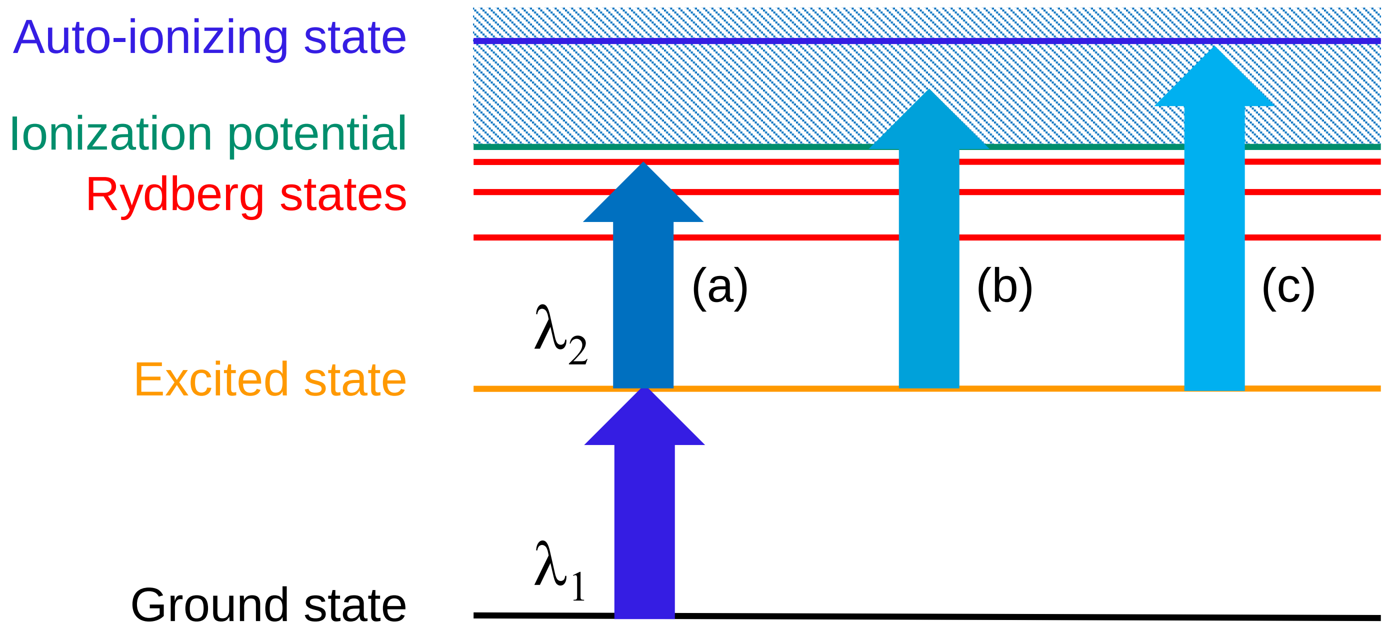


Radiation Detected Resonance Ionization Spectroscopy (RADRIS)

SHIP

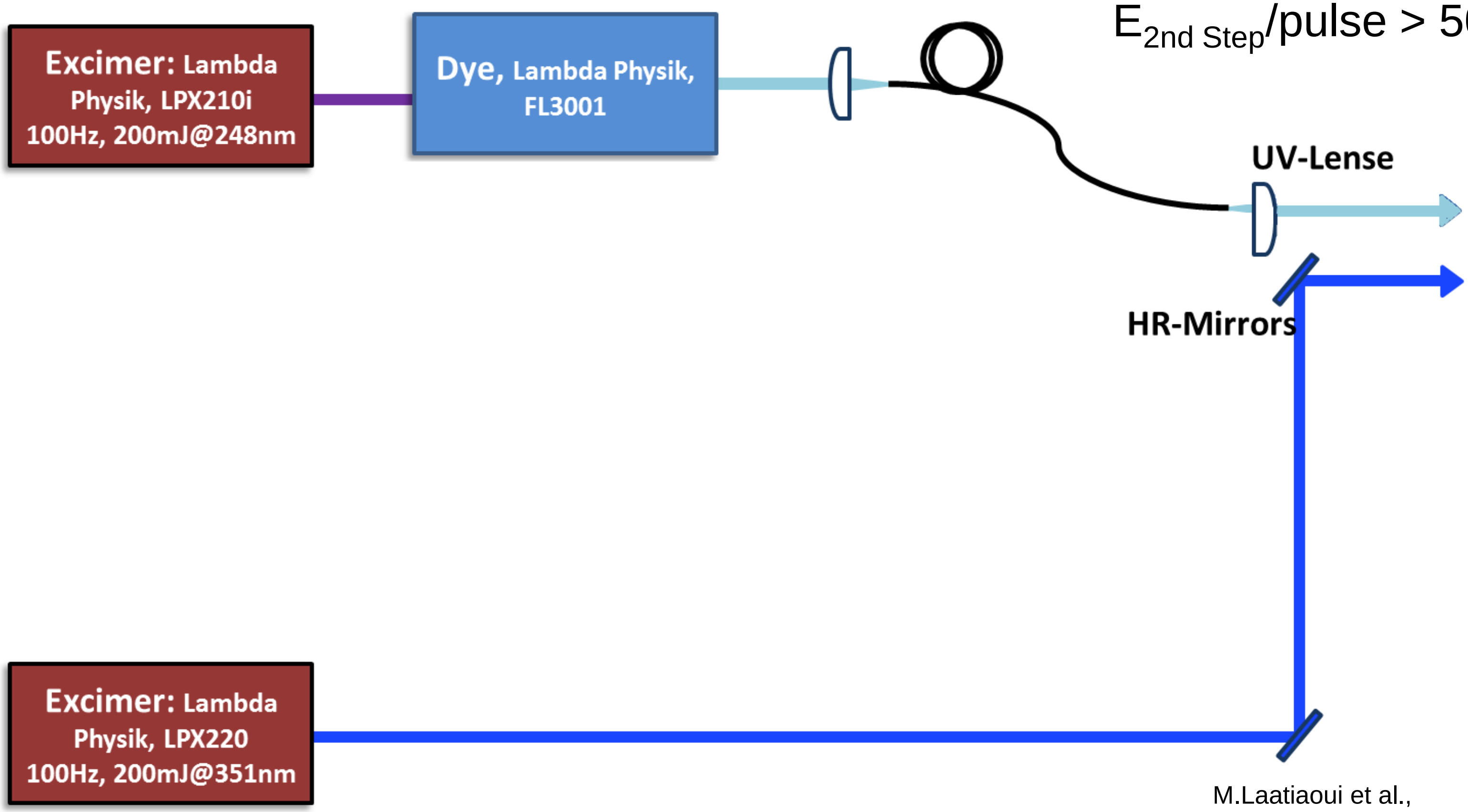


Laser spectroscopy: “2–Step Resonance Ionization”



- 2 orders of magnitude less efficient excitation for scenario (b) compared with (a) and (c)

Laser systems

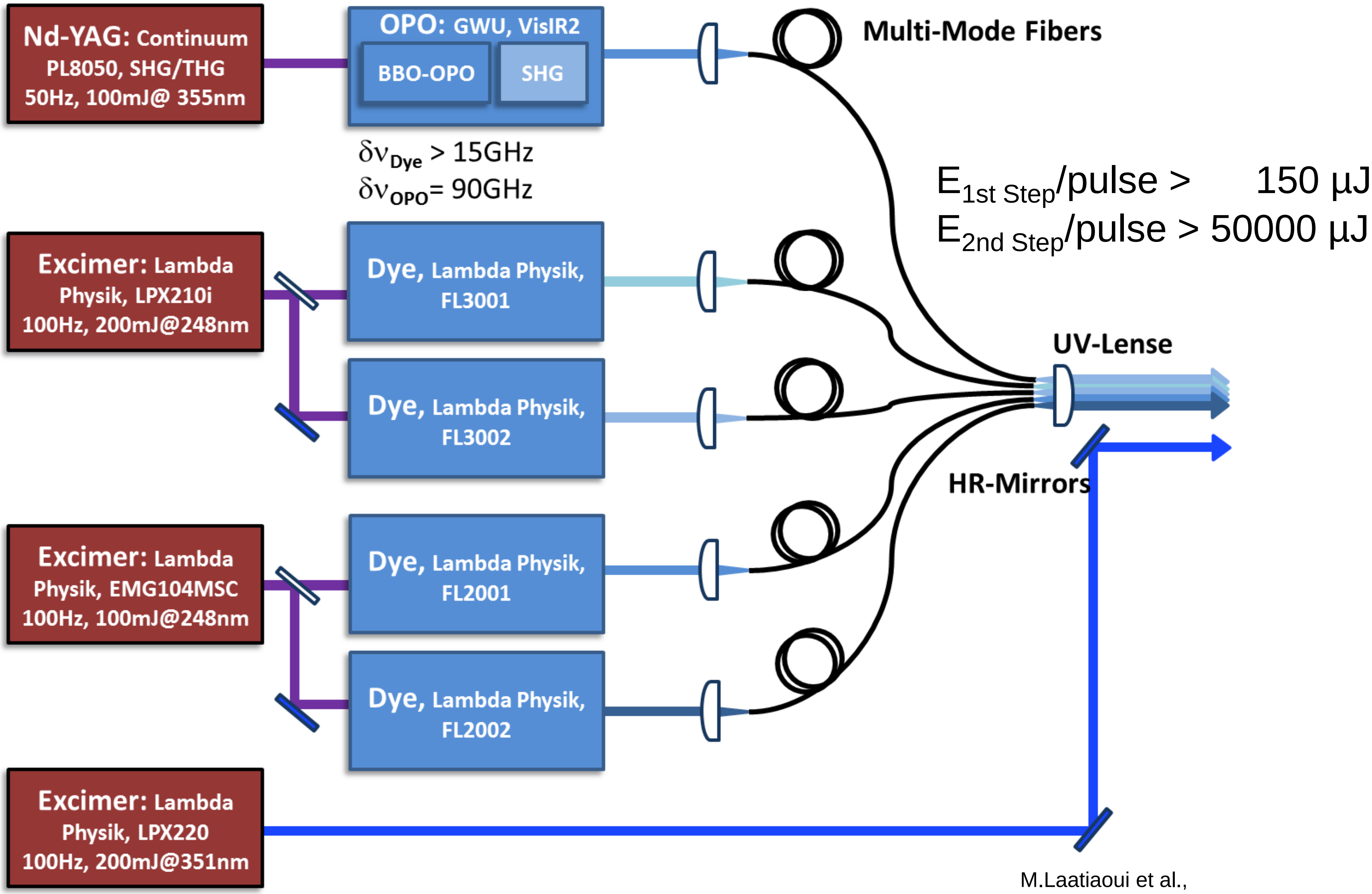


$E_{1st\ Step}$/pulse > 150 µJ

$E_{2nd\ Step}$/pulse > 50000 µJ

M.Laatiaoui et al., Hyperfine Interact. **227** (2014) 69

Laser systems



M.Laatiaoui et al.,
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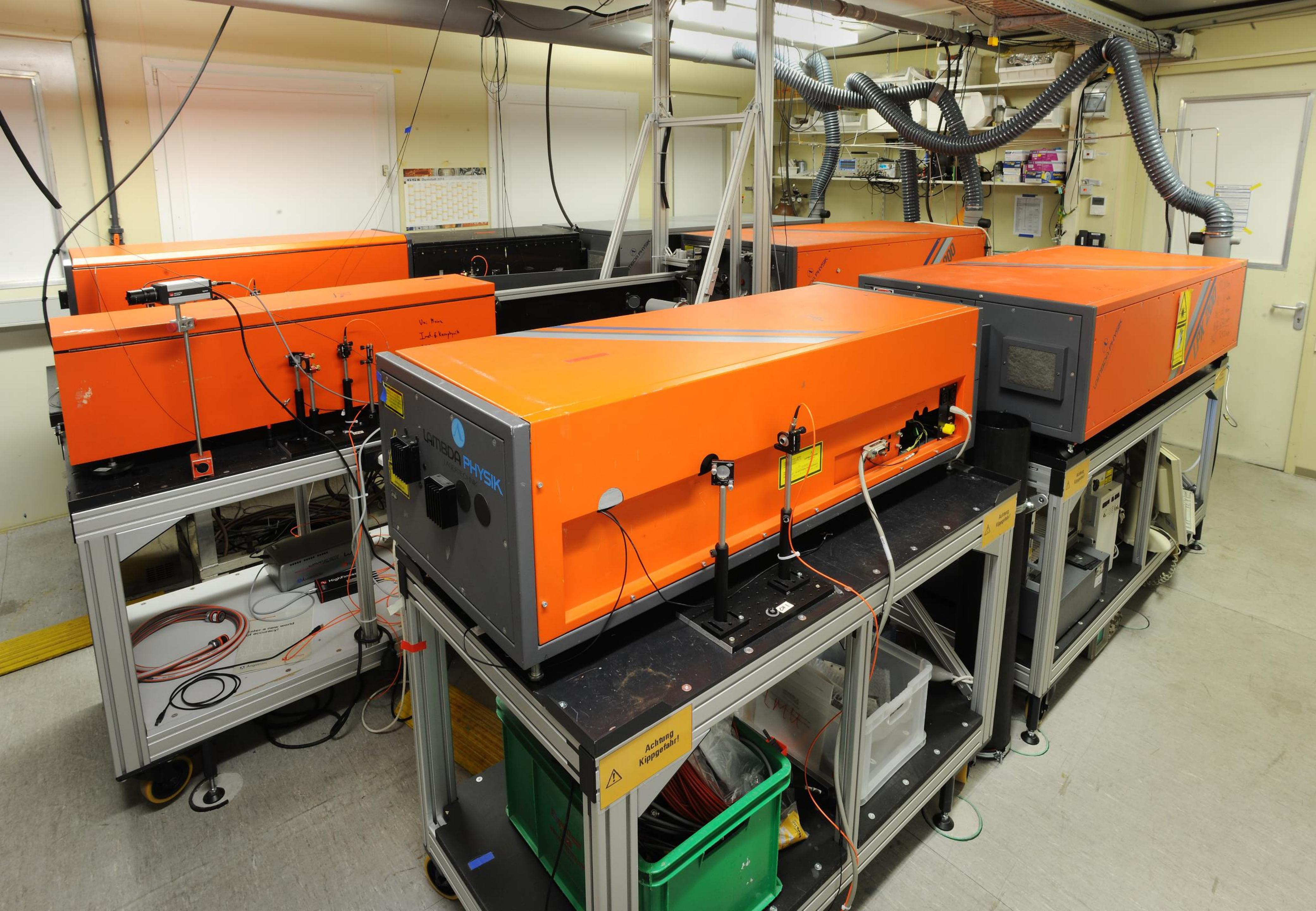
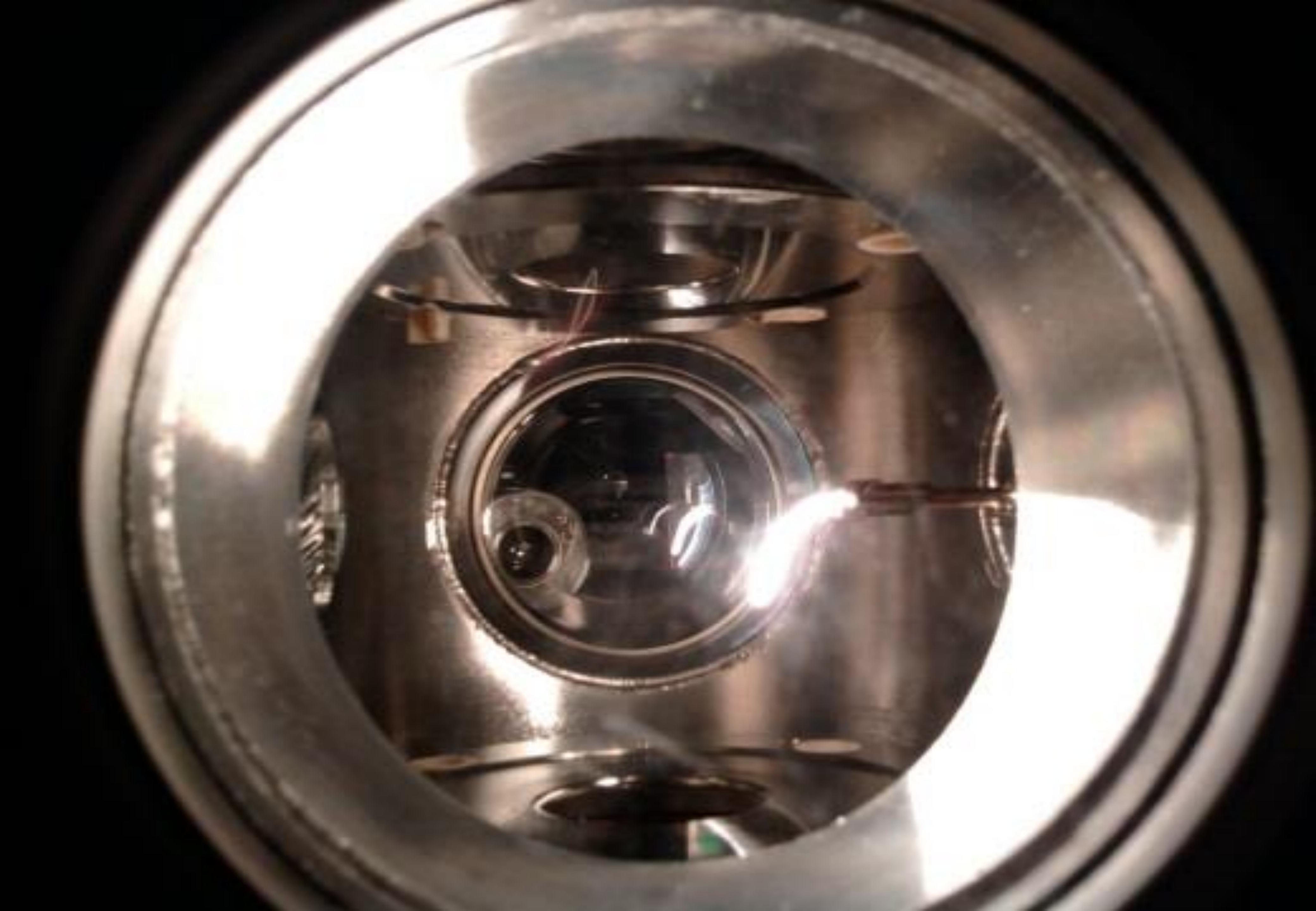
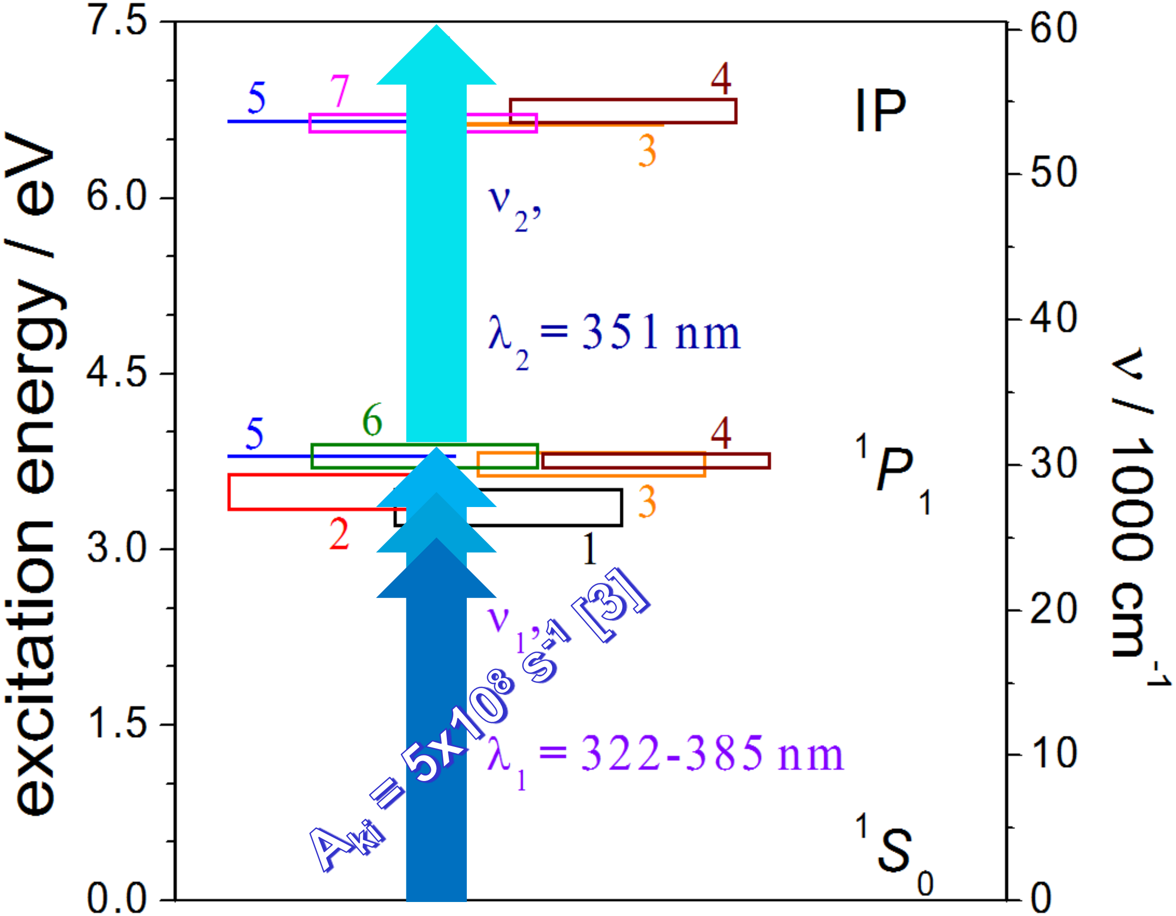

LAMBDA PHYSIK
Achtung
Kippgefahr!



Excitation scheme & predictions



1 (MCDF): S.Fritzsche, Eur. Phys. J. D 33 (2005) 15

2 (MCDF): S.Fritzsche, Eur. Phys. J. D 33 (2005) 15

3 (IHFSCC): A.Borschevsky et al., Phys. Rev. A 75 (2007) 042514

4 (RCC): V.A.Dzuba et al., Phys. Rev. A 90 (2014) 012504

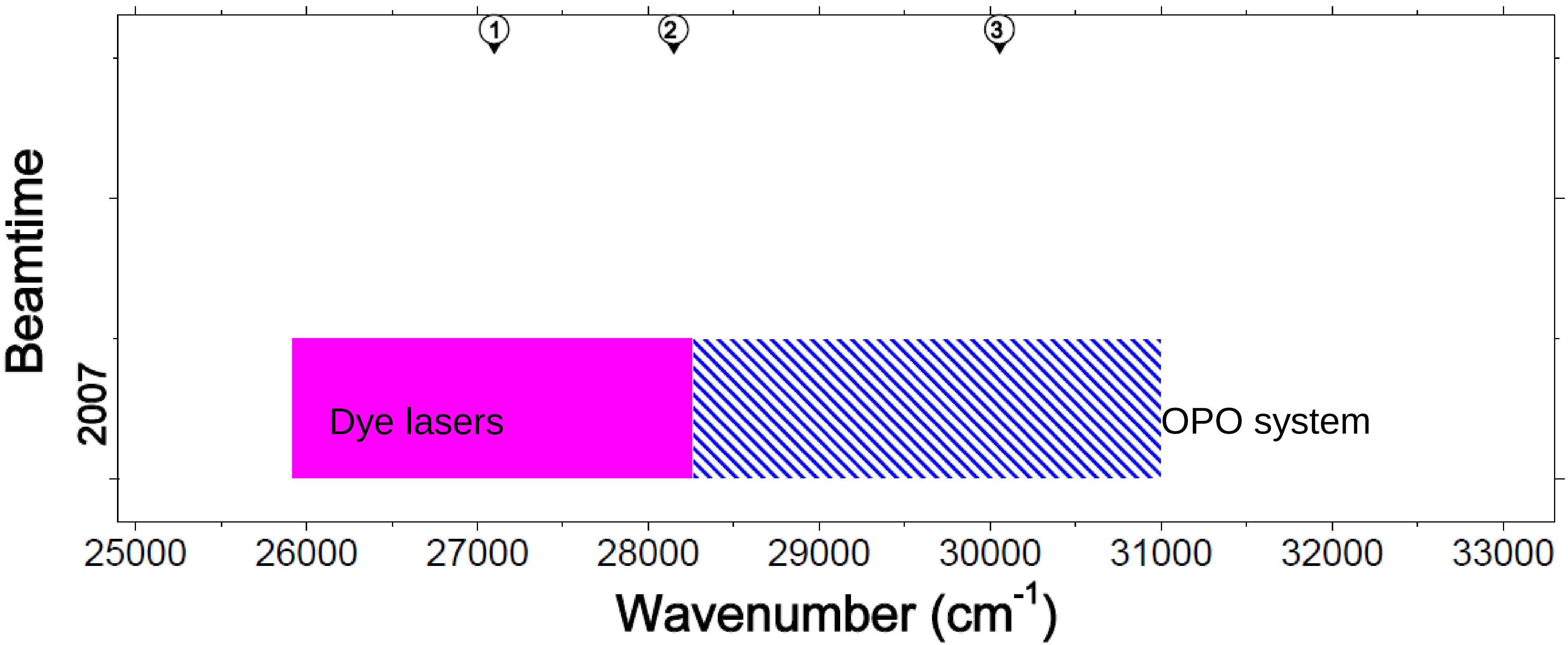
5 (MCDF): Y.Liu et al., Phys. Rev. A 76 (2007) 062503

6 (MCDF): P.Indelicato et al., Eur. Phys. J. D 45 (2007) 155

7 (extrapolation): J.Sugar, J. Chem. Phys. 60 (1974) 4103

Level search in ^{254}No

Year	2007	
Scan range (cm^{-1})	25920 – 31001	
Net scan time (h)	39	



1: MCDF (2005), 2: MCDF (2005), 3: IHFSCC (2007), 4: RCC (2014), 5: MCDF (2007), 6: MCDF (2007)

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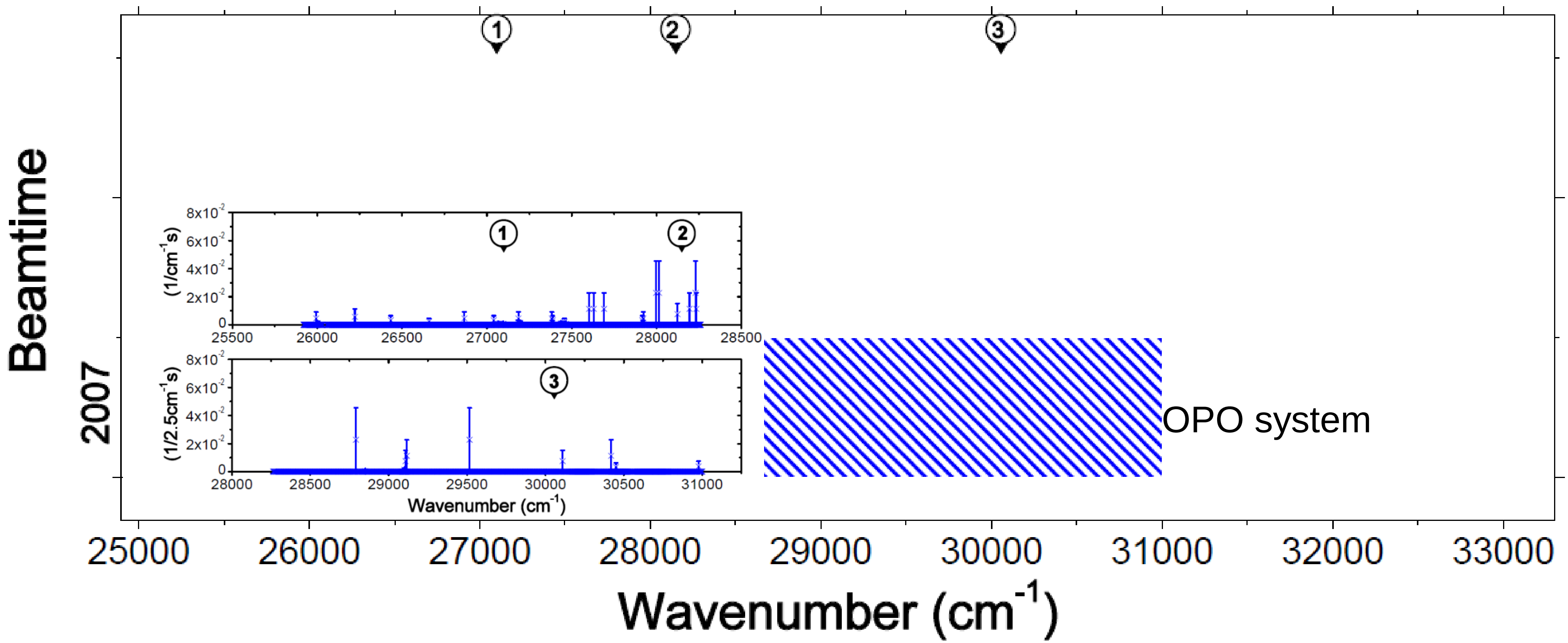

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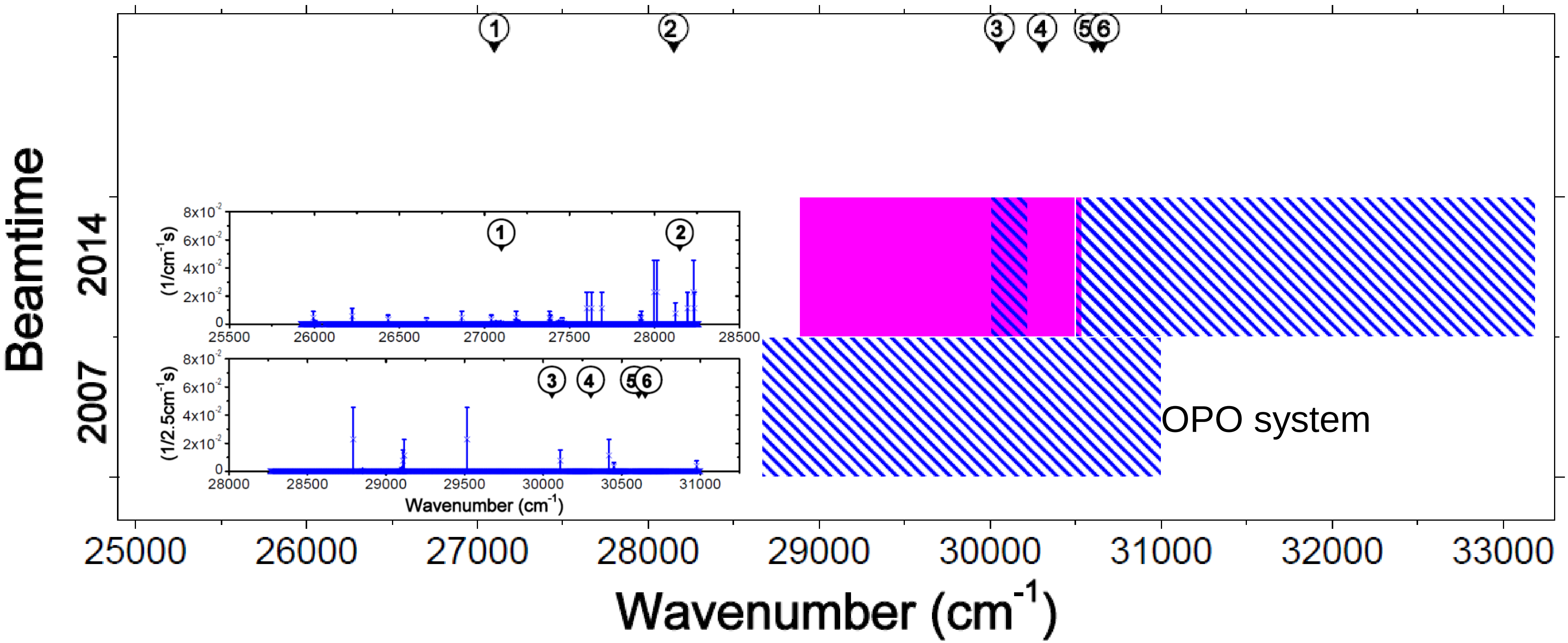

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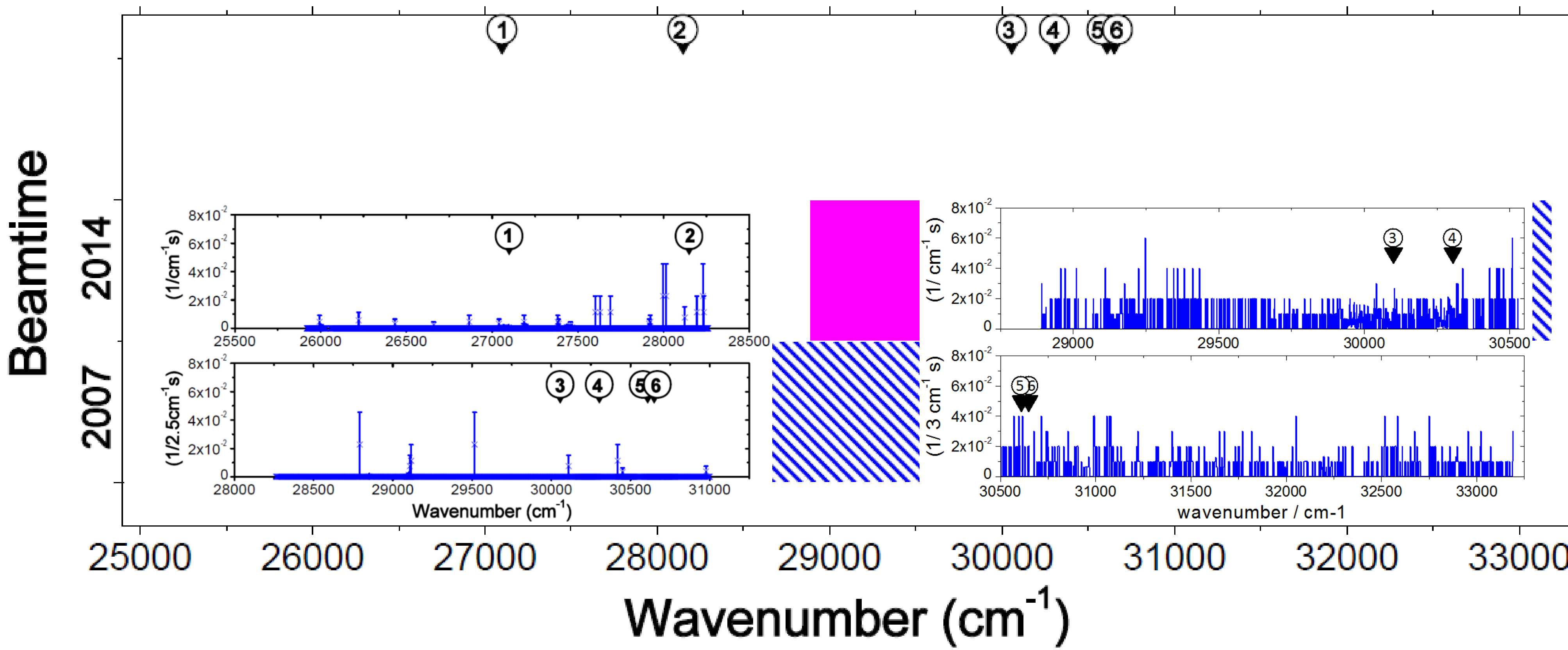

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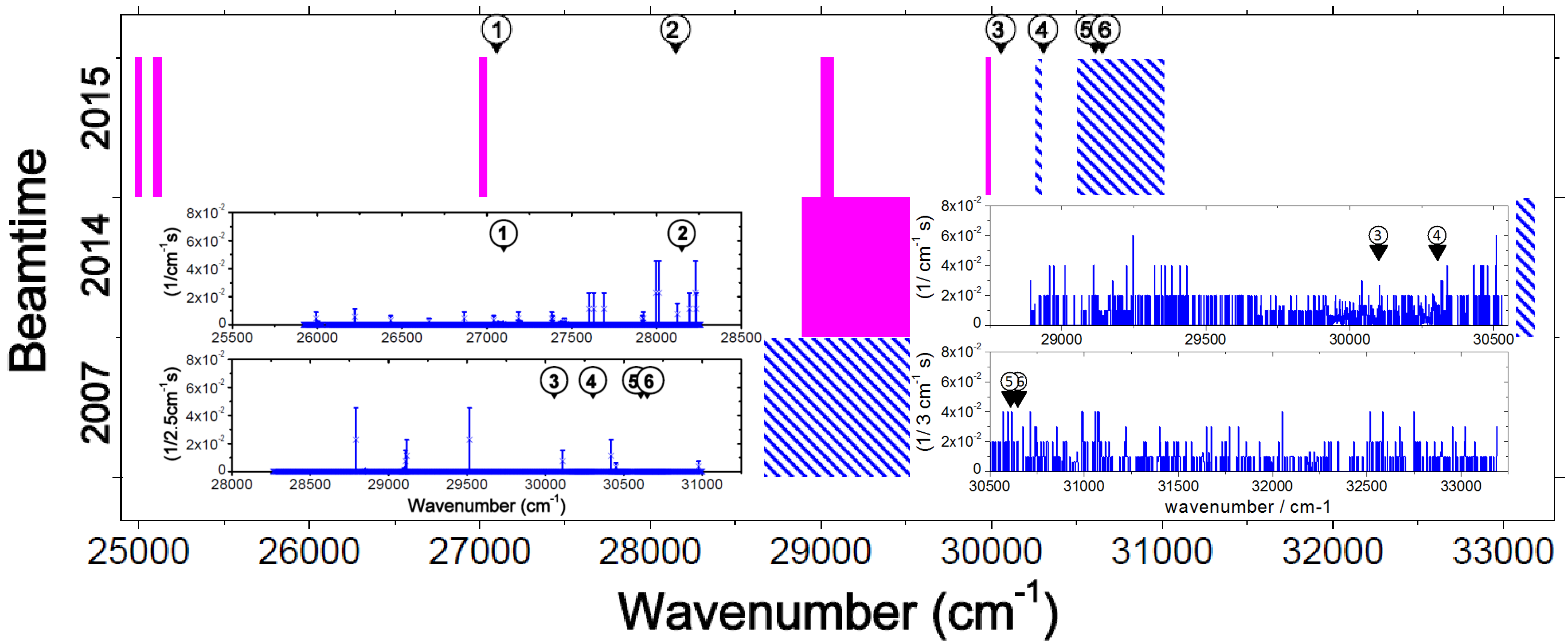

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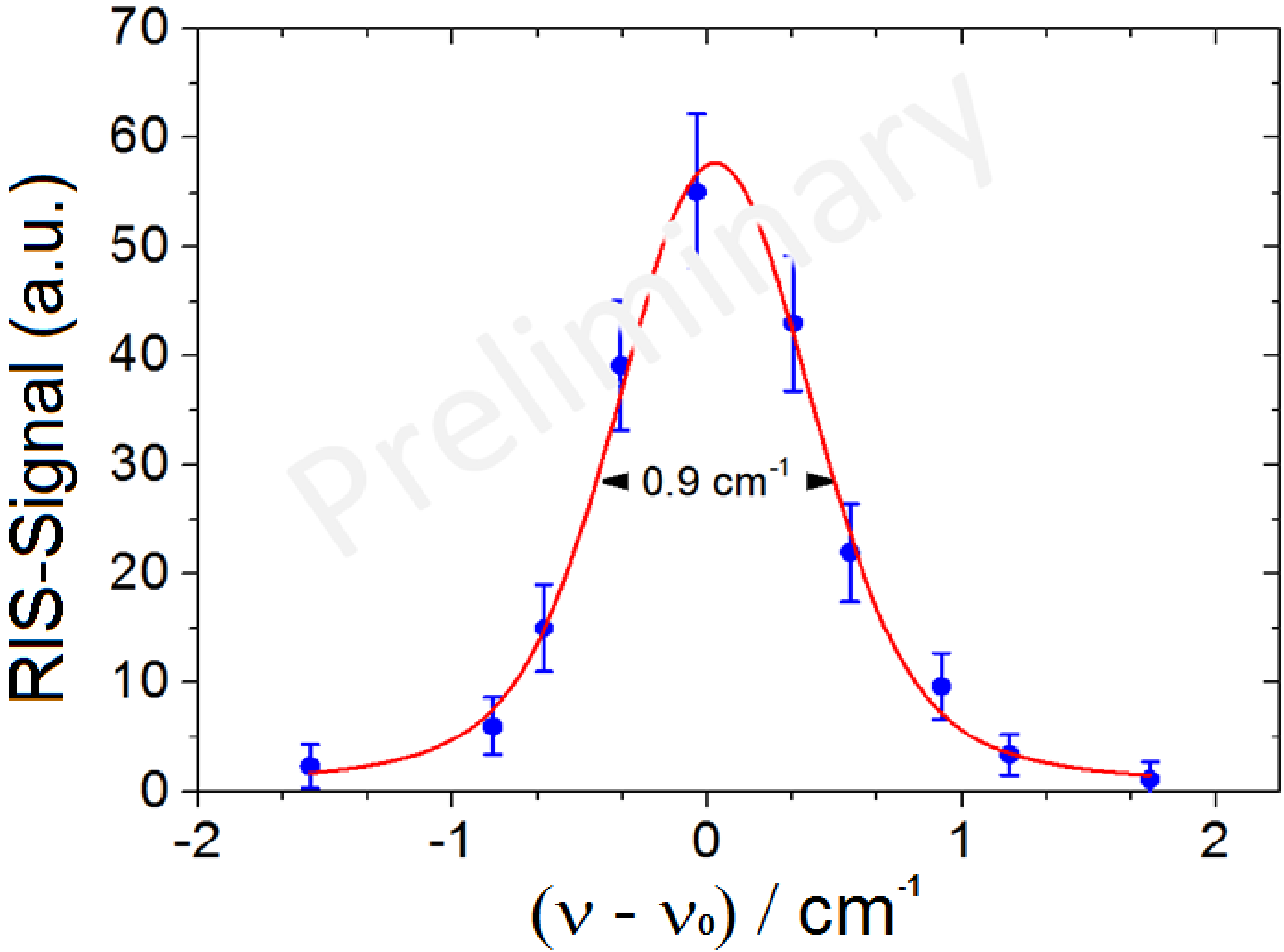
3rd run, 2015: "FINALLY, WE GOT IT!"



Conclusions and future prospects

• Laser spectroscopy of elements beyond fermium is possible!

• The detected resonance corresponds to the strongest ground-state transition in the nobelium (Z=102) atom, the $^1S_0 \rightarrow {}^1P_1$ – transition.

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FUTURE:
• More Rydberg studies in nobelium
• Laser spectroscopy of the element lawrencium (Z=103)…

Thank you for your attention!

RADRIS Collaboration (2014-2015):

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